

## Activities in the frame of the FCH-JU

### DIAMOND project overview

<sup>1</sup>R.C. Makkus

<sup>1</sup>HyGear Fuel Cell Systems

*\*Corresponding author e-mail address: robert.makkus@hygear.com*

The DIAMOND project aims at improving the performance of solid oxide fuel cells (SOFCs) for CHP applications by implementing innovative strategies for on-board diagnosis and control. These are able to detect stack and system faults, analyse the state of health of the stack, and adapt the system to operate in its most efficient point. The project is a follow-up of the projects Genius and Design.

The developments within the project are tested on two different SOFC systems; an integrated stack module (HoTbox©) and a middle-scale CHP with conventional layout.

Models for both systems have been developed and translated into a monitoring model. The models are used for monitoring the system. Using fault tree analyses fault signatory matrices are made which are used for the Fault Detection and Isolation, FDI. These analyses are translated into algorithms and used for monitoring the systems. The applicability of the approach will be assessed by introducing a fault in the system.

A large number of possible faults have been identified, for both systems fuel and air starvation are considered to the largest impact on the stack performance and lifetime.

Several diagnostic tools have been developed; the applicability of Total Harmonic Distortion Analysis has been assessed. Additionally Soft Sensor have been developed and validated. The Soft Sensors are capable of to estimate the minimum and maximum stack temperatures.

For the control of the system several feedforward-feedback loops have been developed as a low-level control. Additionally a supervisory optimizer has been designed. It determines set-points for the low-level controllers in order to maximize electrical efficiency and satisfy process constraints. The optimization is performed directly on the process - precise model of the system is not needed.

#### **Acknowledgements**

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n° 621208 (Project DIAMOND).